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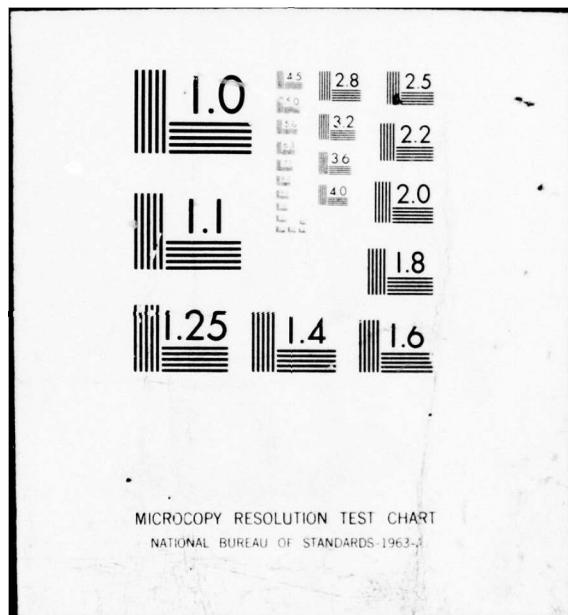
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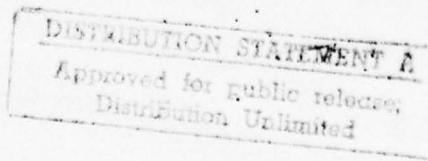
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widely used sociometric questions. The protocols revealed that individuals evaluated their peers along five primary behavior categories: (1) Mutual Influencing, (2) Categorizing/Summarizing, (3) Social-Directive, (4) Quantity of Verbal Communication, and (5) Listening. The protocols were then used to develop a scoring method of the videotaped group interactions, which included content scoring of the verbal interactions and the nonverbal behavior (i.e. head nodding, eye contact, openness, etc.). Two experiments were conducted, one using Duke University students and the second using officers of the Naval Postgraduate School in Monterey. Using first order models only, high rank correlations (r range up to 1.000) were obtained between the peer ranking predicted by the models and the actual peer rankings. The findings are quite relevant to the literature on the attribution process of leadership.

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Decision Process Models of Peer Nominations

Introduction

In a comprehensive review of the literature on peer nominations, Lewin and Zwany (1976) concluded that "peer ratings have been empirically shown to have high validity in the prediction of diverse future performance criteria" (p. 423). They noted a lack of theory in this area, and that there was a need for an explanation of the actual peer rating process. It is the objective of this research to develop an information processing theory of the judgemental process in which individuals engage while rating their peers. Following the research paradigm proposed by Lewin and Zwany (1976), empirical descriptive/predictive models of the peer nomination process are derived, using a class of empirical decision process models of the thought process people engage in while rating each other. Utilizing protocol tracing methods, decision process models are constructed on how individuals rate their peers on seven widely used sociometric questions: (1) Who would you go to for help on a tough problem?; (2) Who is pulling most for the group?; (3) Who was best at handling people?; (4) Who has the most ability to think critically and analytically?; (5) With whom can you work best?; (6) Who shows the greatest independence of thought?; and (7) Who has the best overall leadership qualities?

The research reported in this paper represents an initial attempt to identify and test the predictive validity of these decision process models. It should be noted that two separate but identical studies were conducted. Study 1 utilized Duke University students and Study 2 utilized Naval officers who were students at the Naval Postgraduate School in Monterey. This paper will only report the results from Study 1.

Protocol Tracing and Information Processing Models

Part of the difficulty in developing a model of decision process behavior comes from the empirical procedures often employed. In previous research on decision behavior, subjects are viewed as a "black box." In otherwords, focus has been directed toward the end product of the decision process and not on the actual process of how the subject reached the decision. What information is being processed in the subject's mind?

Slovic and Lichtenstein (1971), in their review of the literature dealing with the modelling of human decision making, concluded that: "The evidence to date seems to indicate that subjects are processing information in ways fundamentally different...[from those of the traditional regression and Bayesian approaches]....we will have to develop new models and different methods of experimentation." (p. 729) They suggest that a promising strategy for the development of a theory of human judgement, is the technique of cognitive process modelling.

The theory and empirical research on information processing can be traced to the work by Newell, Shaw and Simon (1957). Their theory is built on the premise that such processes as thought, verbal behavior, and problem solving behaviors are performed as sequential information processing steps. These "elementary processes" consist of such operations as: storing information in familiar symbols or "chunks", retrieving it, moving it, generating transformed data, comparing two symbols for equality, and associating two symbols. In otherwords these elementary processes are simple logic manipulations of data.

The basis of cognitive process modelling theory is that individuals solve a problem by first developing a problem space --- a psychological representation of the task environment. Intelligence, the information available to an individual from his memory, and the objective task environment determine the problem space. Next, the space is searched for a solution by means of a program. In otherwords, the individual will operate upon his information until he achieves his goal. The fundamental limitation on this solution process is the ability of the individual to store data in a dynamic (quickly alterable) memory. Newell and Simon (1972) conclude that individuals cannot store more than five to seven symbols in a dynamic memory; therefore, one expects to find no more than five to seven dimensions to a problem which will be considered, no matter what its complexity. Actually, individuals usually consider fewer than five aspects of a problem. Newell et.al. (1972) contend that abstractions from "reality" characteristically involve perhaps only two symbolic representations at any given time.

Cognitive process programs are constructed from information elicited by a subject while performing a task. One method of collecting this information is by obtaining a verbal self-report from the subject as he solves a problem. This record of the subject's reported thought process is known as a protocol. The value of this method of obtaining the decision process behavior, has been noted by Simon (1976): ".....[a] technique....used to increase the density of observations of the information-processing system stream [is] recording think-aloud protocols of the problem solver's verbalizations during his activity." (p.28) Similarly Payne (1976), in an analysis of the various models of decision making, concluded that asking subjects to "think aloud" while making

their decisions, provides valuable insights into the information processing strategies which led a subject to make a particular choice. Newell (1966) has developed a methodology for the analysis of protocols based upon content analysis. His procedure allows for the discovery of the patterns of thought which underlie behavior.

Protocol tracing techniques were successfully applied on an exploratory basis by Akula (1969) to develop cognitive process models of the peer rating process. He concluded:

....."there was a significant tendency for the [subjects] to use only a few standards in reaching peer rating evaluations.....Therefore, these results suggest that the selections made by peer rating protocols tend to involve only one or two key dimensions which are quite common to the protocol respondents. The protocol methodology facilitated the identification of behavioral dimensions affecting the peer rating process. This source of empirical information provided the basis for formulating conceptual frameworks (models) of these dimensions in a sequential relationship." (p. 72-73).

Since the judgemental process of peer evaluations can be viewed as a special case of problem solving behavior, then the next steps involve identifying the problem space (perception of the task environment), and the program used to search the space for a solution (the cognitive processes which result in the actual peer ratings). Problem spaces and programs are isolated from protocols and interviews with "performing" subjects. Once the program is isolated, the empirical-level theory has been developed.

Therefore, the strategy used in this study was to derive descriptive/predictive models of the peer nomination process using protocol tracing techniques. In otherwords, this approach involves developing decision process theories from an analysis of the data -- verbal

self-reports of subjects' thought processes while engaged in making peer judgements.

METHOD

Overview

The procedure in these studies was adapted from Akula (1969). The experimental environment simulated managerial decision making. It was chosen because the predictiveness of peer evaluations.... "depends in part upon how closely the rated activities simulate real-life leadership situations." (Roadman, 1964, p. 211). The sociometric instrument used in this research was composed of seven items that Hollander (1965), Weitz (1958), and Roadman (1964) found to be valid predictors of future performance.

Two studies were conducted: the first with Duke University students as subjects, the second with officers at the Naval Post-graduate School in Monterey. Subjects were members of seven-person teams participating in a management simulation. They were to assume the role of management consultants hired by a hypothetical company. After reviewing the present state of the company, they were to analyze its problems and arrive at initial recommendations to be made to top management. In order to make sure that no person was predesignated as the group leader, it was arranged for them to convene in the absence of the project team leader. Ten such teams were run in each study.

Each simulation required approximately 2 1/2 consecutive hours to complete. A total of six phases comprised the entire procedure: (1) subjects received an orientation; (2) case material about the hypothetical company was read individually by each student; (3) the case was jointly discussed and analyzed by the group to arrive at preliminary recommendations (this phase was videotaped); (4) subjects viewed themselves on videotape; (5) the seven item peer evaluation forms were completed; and (6) protocols were obtained for each of the seven questions in both studies.

The procedures in the two studies were identical. In addition, all subjects in Study 2 were administered various personality tests. The tests administered included the Edwards Personality Preference Schedule, the California Psychological Inventory, the Least-preferred Co-worker Score, a test for Machiavellianism, and the California F-test for authoritarianism. At this time the analysis for Study 2 has not yet been completed. Therefore, only the results for Study 1 will be presented in this paper.

Subjects. All subjects in Study 1 were summer school students at Duke University. The 65 participants were all of college age and were paid volunteers. The sex mix was not controlled resulting in a random distribution of males and females for each of the test teams. Full attendance was assured by over-scheduling each test session by one or two persons. If eight persons showed up for the testing, one member was assigned to be the project team leader who was subsequently excused after the individual reading of the case. Despite these extra efforts, one group was short one subject and another was short two subjects.

Prior acquaintanceship was minimized as much as possible. However, on occasion two friends did participate in the same group. Before the start of each test session an indication of prior acquaintanceship and/or friendships was obtained.

Stimuli. The stimuli was a peer evaluation questionnaire.

It consisted of seven items selected from those that Hollander (1965), Weitz (1958), and Roadman (1964), found to be valid predictors of managerial success. The questions were as follows:

1. Who would you prefer to go to for help on a tough problem? (Weitz)
2. Who is pulling most for the group? (Weitz)
3. Who is best at handling people? (Weitz)
4. Who has the most ability to think critically and analytically? (Roadman)
5. With whom can you work best? (Weitz)
6. Who shows the greatest independence of thought? (Roadman)
7. Who has the best overall leadership qualities? (Roadman)

Subjects were asked to exclude themselves and rank the members in their group from first to last on each of the questions.

Although the set of questions in the peer rating instrument consisted of seven items, each questionnaire booklet contained only six of the seven sociometric measures, with one question systematically omitted from each booklet. The procedure was constructed in such a way that the subject would have an unfamiliar question for which to give a protocol. In order to achieve an equal number of protocols for all seven measures, the omitted question alternated in each booklet.

Procedure. (Phase One) Subjects were seated in a semi-circle facing the videotape camera. Recent research indicates that this physical arrangement is not detrimental to group behaviors (Lonetto, 1973). Subjects were told that they were involved in an exercise examining how a group approaches an unstructured problem situation. They were told what the entire process would involve, briefly describing each phase of the exercise, and that their group discussions would be videotaped. It was stressed that the researchers were not interested in anything about them as individuals. Each participant wore a name tag bearing only his or her first name to insure anonymity. They were also asked to make an effort to match the names with the faces of the other members in the group to facilitate later recall.

(Phase Two) Case material was distributed along with a pencil and writing pad for note taking, if desired. Approximately 20 minutes was allowed for reviewing the case.

(Phase Three) Instructions for this phase of the experiment were re-read. Subjects were told they were now to convene as a project staff meeting to prepare preliminary recommendations. They were also meeting in the surprise absence of the project team leader who was called away on urgent business. If an eighth team member was present, he was excused at this time as the leader. The videotape was started and discussion was stopped after 30 minutes.

(Phase Four) The videotape of the group discussion was replayed for the purpose of letting the subjects see how they functioned as a group and to refresh their memories as to what was said. Interest in the replay was usually lost within 15 minutes, wherein the next phase was begun.

(Phase Five) The peer evaluation instrument was distributed. Subjects were asked to disperse around the room in order to fill out the questionnaires in greater privacy.

(Phase Six) After the questionnaire was completed, each subject was taken into a separate office to be interviewed privately. At the start of the interview, permission was obtained for recording the session and the subject was told that he could listen to the tape at the conclusion of the interview if he desired. The recorder was then started to get the subject comfortable with a tape recorder before the actual question was asked. He was then told that the researchers' main interest was in the thought process involved in making a decision. The subject would be asked to think aloud, to verbalize his thoughts, as he answered a question similar to the ones in the questionnaire. He was to say whatever came into his mind, however silly, impolite, irrelevant, fragmentary or unimportant. And whenever he should fall silent for more than a moment he would be asked "to please talk...."

Next a practice question was tried to give the subject an idea of what it was like to verbalize his or her thoughts. The question used was a simple cryptarithmetic problem. Subjects were to solve, by thinking out aloud, the values of the letters B, O, and J, given the value of the letter E and the numeral value of the sum:

$$\begin{array}{r} \text{B O B} \\ + \underline{\text{J O E}} \\ \hline 627 \end{array} \qquad \qquad \qquad \text{E} = 3$$

After the subject solved the trial problem aloud, it was reviewed, pointing out the entire thought process, e.g. "You said, or should have said, 'since E equals 3, and this is a problem in addition, then 7 minus

3 equals 4, therefore, B equals 4 because 4 plus 3 equals 7,' etc. What the researchers are after is a statement of the entire chain of thoughts."

Next the relevant experimental sociometric question was presented. The subject was told to think back of the group interaction, and again, excluding himself, to rank the members in his group from first to last remembering to verbalize everything that he is thinking. The question was then read to the subject and also presented on a 7" x 9" index card placed before him for reference. In addition, the seating arrangement of the group was made available to the subject to help him recall who was who.

During the subjects verbal report, the interviewer would write down what appeared to be nonoperational statements and code words for complete thought process strings which the subject would verbalize in his evaluations. Examples are the use of code words such as "intelligent", "friendly", etc. The operational meanings of these words or phrases were then explored with the subject.

At the conclusion of the interview, when the subject had no more thoughts, all questions or comments that he might have concerning the experiment were answered; and he was allowed to listen to his recording. Subjects were informed that the results of their peer evaluations (i.e. how they were perceived by their group members) would be available upon request. Only aggregate ranks were reported to maintain anonymity.

For samples of all instructional materials, the case, and questionnaires see Technical Report No. 2.

RESULTS

Protocol Analysis

A complete transcript of the verbal reports given by each subject was made. Using the procedure suggested by Newell and Simon (1972), the protocols were broken up into short phrases each representing the subjects' assessment of how he was ranking a person a particular way. Newell and Simon (1972) have shown that breaking verbal protocols into small phrases "goes a long way towards isolating a series of unambiguous 'measurements' of what information the subject had at particular times" (p. 166).

Once the protocols were broken down into short phrases they were then analyzed for operational and nonoperational information processing descriptors of the subject's thought process. Operational descriptors refer to statements about behavior which are tangible, observable and measurable. For example, the statement "agreed with me" is defined as operational because it connotes a specific agreement, which can be reliably scored. It is also possible to signify agreement with a non-verbal communication which can also be reliably scored (e.g. head nodding). However, the statement "he seemed personable" is considered to be a non-operational verbal description. It does not suggest any specific behaviors which the person being described, engaged in, that make him "personable."

Group Videotape Content Analysis

From the analyses of the protocols, various content categories were identified, (e.g. gives direction, summarizes, asks questions, etc.)

These categories -- suggested by the protocols as being the chunks of information used by an individual in making decisions -- were then used as the basis for analyzing and scoring the content of the videotaped group interactions. Initially, only verbal communications were content analyzed and scored. It became evident, however, that subjects were also processing a variety of nonverbal cues for which no operational definitions were available. Subjects for example evaluated the extent to which other group members were "listening", seemed "open and relaxed" and so forth. A study of the nonverbal literature (Knapp 1972; Mehrabian 1972) indicated that the nonverbal behavior (e.g. listening, dominance, immediacy, etc.) could be reliably scored and thereby significantly increase the subset of information being processed by the subjects.

Searching the record of the verbal transactions for these content categories in each group videotape involved three time consuming steps:

- 1) A sequential list of the order of speakers was made by two observers who independently recorded this information, after which the two lists were cross checked and reconciled.
- 2) The audio was transcribed. This time consuming step greatly facilitated the analysis of the verbal transactions. Once a transcription was made of each videotape, each verbal comment was analyzed and scored as to which content category it belonged. For example, the statement "Yes I agree, and what you said could also apply to Marketing because",

would be scored as an agreement, and as building on a previous statement.

- 3) The videotape was scored for nonverbal communications, (e.g. headnodding, listening, eye contact, etc.). As was suggested by Heimann and Heimann (1972), the videotape was viewed "with and without sound for concentration on the nonverbal expressions that direct observation diffuses" (p. 80). Again, two observers scored these categories independently.*

From this record of the communications, each individuals' contributions were extracted and summed. In otherwords, for each subject a record was made of the number of times he agreed, disagreed, expressed an opinion, etc. This data was then used as inputs to the peer ranking models for predicting how a subject would be rated on each sociometric by the group.

Decision Process Models

No a priori models of the subjects decision behavior were postulated in this research. The protocol tracing methodology is intended to provide a process description of the information processing strategies employed by subjects while evaluating their peers.

It was expected that a content analysis of the descriptors (operational and nonoperational), obtained from the decomposition of each

* The median interrater agreement was .98 with a range of .9643 to .9983

protocol, would identify a few key dimensions which subjects considered in evaluating their peers. Based on prior research and a review of the literature (Lewin and Zwany 1976) it was expected that these dimensions would be situationally common for a particular sociometric question. In other words, a common core of criteria used by subjects to evaluate their peers on a particular sociometric question for the Duke subjects was expected to be found. The models which were developed and the initial results of the analysis are considered to be the simplest and most naive.

Since an examination of the protocols yielded only information categories considered by subjects without providing any indications as to priority levels of the information, a simple unweighted additive model was hypothesized for each sociometric question. The basic model for each question considered only the common primary factors which appeared in each protocol. For example for sociometric question #5, "With whom can you work best?", the single primary factor was:

Mutual Influence - the existence of give and take in the interaction between two or more group members with no individual imposing his ideas or trying to dominate the interchange.

From the extracted descriptor phrases in the protocols, several recurring themes were gleaned. A frequency analysis of these phrases suggested the following primary factors: (1) a Mutual Influencing exchange (MI), (2) having the ability to Listen (L), (3) the Quantity of Verbal Communication (QVC), (4) engaging in a Social-Directive role (SD) and (5) Categorizing and Summarizing information (C/S). The primary factors which were employed in the basic unweighted additive models for

each sociometric question are summarized in Table 1. The frequency with which these factors occurred in the protocols for the particular sociometric is also presented.

Table 1. Summary of Key Parameters for each Sociometric Question

Sociometric	Primary Factors	Frequency Stated in Protocols
1. Who would you go to for help on a tough problem?	MI L	32% 32%
2. Who is pulling most for the group?	SD L QVC	27% 27% 24%
3. Who is best at handling people?	SD MI	42% 31%
4. Who has the most ability to think critically and analytically?	QVC C/S	33% 33%
5. With whom can you work best?	MI	60%
6. Who has the greatest independence of thought?	No clear indication	
7. Who shows the best overall leadership qualities?	SD MI	48% 32%

In the following section excerpts from the protocols are presented. These descriptor phrases aid in the understanding of the meaning of the primary parameters. For a sample of a complete protocol transcript see Technical Report No. 2.

The Mutual Influence factor is identified by the existence of three behaviors: (1) a give and take exchange, (2) having the ability to listen, and (3) not being overly dogmatic or aggressive in your views. A give and take exchange is represented, for example, by the following underlined descriptors:

S₁: I feel like if I have someone who's confident of what we can do within reasonable limitations,

then I feel like I can take this information to this person

and he can digest it

and because of his relationship with other people he can expound a bit more intelligently, and a bit more convincingly on my ideas.

There is a give and take between us.

S₂: She agreed with me and thought the same things I thought,

but we both contributed equally.

S₃: He doesn't just agree with you all the time.

S₄: We were jointly finding solutions.

S₅: I agree with what she said, but I could persuade her to my way of thinking sometimes if we disagreed.

The descriptors in a give and take exchange include those which indicate agreement, disagreement and building on another's idea.

The listening aspect of the mutual influencing process is evident in the following descriptors:

S₁: He responds to what people say and draws my thoughts into the group.

S₂: He both listened and spoke.

S₃: She was interested in keeping up all the time, she didn't just sit back, and gave feedback.

S₄: I could work with Laura best because she's willing to listen to you and I don't think she'd dominate or restrict me from adding my side.

I feel like both of us could contribute together and it wouldn't be a one-sided contribution.

It is logical that in order to have give and take, each person involved in the discourse must equally be a listener as well as a contributor to the discussion. Poor listening abilities also characterizes the dogmatic-aggressive individual. Following Rokeach's (1954) definition of dogmatism, the dogmatic person can be described as closed-minded, rigid, and intolerant of other's opinions, especially when they differ from his own beliefs. This quality was evident non-verbally through such cues as rigid body posture, crossed arms, leaning backward outside of the group, etc. These persons were perceived as being cold, aloof, and not open to persuasion. Dogmatism and aggression was described in the protocols by such verbal descriptors as:

S₁: He interrupts

S₂: He was overly aggressive and dominated the conversation.

S₃: He felt like his ideas were the right ones.

and he wasn't open to amendment.

S₄: I felt like he would come down hard on someones negative opinions, and he wouldn't be tactful when he disagreed.

S₅: He smiles and is friendly, gives everyone a chance, and doesn't interrupt.

S₆: She was receptive to other peoples' opinions and is willing to interject her own ideas.

S₇: He was too aggressive and thought things had to be done his way.

I think when you encounter someone who thinks along those lines

there's conflict already

instead of it being a complimentary process towards solving problems

it becomes more of a conflictive type of thing

because you have to overcome the roadblocks they have set up in their own minds.

This rigid, aggressive and dogmatic quality was primarily scored through the nonverbal cues by two independent observers, it was then added to a count of verbal statements of disagreement, agreement, and building expressed by a subject to obtain the final Mutual Influence score.

This factor was found to be of primary importance in the socio-metric "With whom can you work best?". The existence of give and take,

listening, and the absence of dogmatic-aggressive behavior are all combined in the decision of the peer ranking on this question. Mutual Influence was also found to be important in the protocols on "Whom would you go to for help on a tough problem?", "Who is best at handling people?", and "Who shows the best overall leadership qualities?" Curiously enough, however, the components of give and take and listening were represented, but little mention was made that the restrictive nature of the dogmatic-aggressive individual was undesirable on these three sociometrics.

The factor of Listening was apparent in both the verbal and non-verbal communications. It is revealed verbally, for example, in the following excerpts from the protocols:

S₁: She listened and spoke.

S₂: He agreed with me

and I felt like he valued what I said.

S₃: He didn't interrupt when someone else
was talking.

All of these descriptors indicate that someone is listening to what is being said. Nonverbal cues include eye contact, head nodding, leaning forward toward the speaker, etc. Listening was scored by two independent observers who watched the videotapes without the sound (Heimann and Heimann 1972) in order to focus solely on the non-verbal cues. The Listening factor was found to be particularly important in the sociometrics "Whom would you go to for help on a tough problem?", and "Who is best at handling people?"

The factor of Categorizing or Summarizing is exemplified by the following descriptors:

S₁: He was able to follow the conversation and come up with an appropriate observation.

S₂: He crystalized the group thought to summarize.

S₃: He was organized in the way he was thinking about things

He could focus on one thing and move to the next

S₄: I would say something

and she seemed able to draw it together

If people made general statements, she would not only initiate stuff, but categorize it;

like I'd come out with generalizations and she'd categorize it and put it sort of into a pocket.

S₅: He was able to look at both sides of the situation and reach a conclusion.

Each time a subject made a statement which tied two ideas together, review what had already been said, etc., it was scored as a Categorizing/Summarizing behavior. This factor was primarily found in the sociometric "Who has the most ability to think critically and analytically?"

The factor of the Quanity of Verbal Communication (QVC) is revealed in the protocols by such descriptors as:

S₁: He talked the most

S₂: John was most verbal

S₃: She had the most ideas, she contributed the most.

This factor was scored from a count of the number of utterances made by each subject. A finer classification of the Quantity of Verbal Communication was made using the number of opinions stated by an individual as a subset. This measure of verbal participation proved to be a more significant measure and therefore, was used whenever "talkative" appeared frequently in the protocols on a particular sociometric.

This factor was found to be important in making the peer rankings on the sociometrics "Who is pulling most for the group?" and "Who has the most ability to think critically and analytically?"

The Social-Directive factor is characterized by an individual who (1) organizes and gives direction to the group and (2) accomplishes this in a socially acceptable manner. In otherwords, a person ranking high on this dimension not only structures the problem solving process of the group but he or she also involves other group members. This includes, listening, drawing others out, and not imposing one's will. These behaviors are illustrated in the following descriptors:

S₁: He takes leadership by directing the flow of thoughts with his own

S₂: He started the whole discussion off and got things going at the beginning.

When the conversation died down, he would ask if anyone else had any ideas.

He would try to get response from other people.

S₃: He would bring us back on track when the conversation drifted.

S₄: He gave the group structure, told us when to move on, assigned someone to take notes, asked questions of the group and of people who weren't talking to draw them out.

He pushes his ideas over in a pleasant way, and when he spoke we listened.

S₅: He took initiative to start off the whole thing.

S₆: He sat up, said what he wanted to say; Jack has self-confidence.

S₇: She didn't just sit back all the time but she wasn't beligerent in expressing her views either.

This factor was scored by two independent observers who ranked each subject as either high, medium, or low.* The score combined a count of the verbal structuring and consideration behaviors with special emphasis on nonverbal cues such as those indicating readiness, openness, self-confidence, listening, etc.

Social-Directive descriptors appeared most frequently in the protocols on the sociometric "Who was pulling most for the group?", "Who is best at handling people?", and "Who shows the best overall leadership qualities?".

Testing the Models

The development of the models consisted of two parts: (1) the information chunks being processed and used in making the decisions on each sociometric were identified from the protocols; and (2) the decision rules for combining this information in order to make predictions as to the aggregate group peer rankings for each group member were identified. For example, the primary factors in the model for the sociometric question "Who would you go to for help on a tough problem?" are Mutual Influence and Listening. The decision rules

* The median interrater reliability as measured by the Spearman Rank Correlation was .981, with a range between .964 and .998.

for predicting the peer ranking on this question would be to: (i) rank each group member according to the additive score of "agreements," "disagreements", and "building" since these factors compose the Mutual Influence parameter; (ii) rank the group members on the nonverbal cues indicating Listening; and (iii) combine the two rankings. This final ranking is then statistically compared to the actual aggregate group rankings. The decision rules for all of the sociometrics are as follows:

- (1) Who would you prefer to go to for help on a tough problem?

Primary parameters: Mutual Influence and Listening Information processing rules:

i - Rank group on Listening (L)
ii - Rank group on Mutual Influence (MI)
iii - Combine the rankings

- (2) Who is pulling most for the group?

Primary parameters: Social-Directive, Listening and Quantity of Verbal Communication Information processing rules:

i - Rank group on Social-Directive (SD)
ii - Rank group on Quantity of Verbal Communication (QVC)
iii - Rank group on Listening (L)
iv - Combine the rankings

- (3) Who is best at handling people?

Primary parameters: Social-Directive and Mutual Influence Information processing rules:

i - Rank group on Mutual Influence (MI)
ii - Rank group on Social-Directive (SD)
iii - Combine the rankings

- (4) Who has the most ability to think critically and analytically?

Primary parameters: Quantity of Verbal Communication and Categorize/Summarize Information processing rules:

i - Rank group on Quantity of Verbal Communication (QVC)
ii - Rank group on Categorize/Summarize (C/S)
iii - Combine the rankings

- (5) With whom can you work best?
Primary parameter: Mutual Influence
Information processing rule:

i - Rank group on Mutual Influence (MI)
- (6) Who shows the greatest independence of thought?
Primary parameters: No clear indication from protocols
- (7) Who shows the best overall leadership qualities?
Primary parameters: Social-Directive and Mutual Influence
Information processing rules:

i - Rank group on Social-Directive (SD)
ii - Rank group on Mutual Influence (MI)
iii - Combine the rankings

It is on the basis of such naive information processing rules that predictions were made for each group as to their rank order on each sociometric question. Tables 2-7 summarize the results for Study 1 for each sociometric question. In each case, the Spearman rank correlation coefficient is calculated for each of the information processing rules.

An additional model is shown for the sociometric "Who is pulling most for the group?" The decision rules are as follows:

- Primary parameters: Social-Directive and Quantity of Verbal Communication

Information processing rules:
i - Rank group on Social-Directive (SD)
ii - Rank group on Quantity of Verbal Communication (QVC)
v - Combine the rankings

This new model, omitting the Listening factor, proved to be a more significant predictor of the group peer ranking for all groups except one, of these, all were significant at the .05 level with four significant at the .01 level.

Table 2. Spearman rank correlation between actual aggregate peer rankings and predictions based upon the information processing rules.

1. Who would you go to for help on a tough problem?

Group	Information Processing Rules	i L	ii MI	iii L + MI
1		.919**	.776*	.830*
2		.785*	.464	.669
3		.928**	.785*	.875*
4		.785*	.776*	.758*
6 ^a		.625	.825	.975*
7		1.000**	.785*	.937**
8		.893**	.571	.633
9 ^b		.642	.642	.642
10		.571	.750*	.758*

^an = 5

^bn = 6

* $p > .05$

** $p > .01$

Table 3. Spearman rank correlation between actual aggregate peer rankings and predictions based upon the information processing rules.

2. Who is pulling most for the group?

Group	Information Processing Rules					
		i SD	ii QVC	iii L	iv SD+L+QVC	v SD+QVC
1		.946**	.785*	.893**	.893**	.893**
2		.946**	.857*	.642	.955**	.893**
3		.928**	.857*	.821*	.883*	.857*
4		.991**	.875*	.893**	.982**	.964**
6 ^a		.700	1.000**	.625	.800	.900*
7		.955**	.794*	.901**	.928**	.937**
8		.964**	.732*	.839*	.803*	.839*
9 ^b		.728	.071	.314	.271	.457
10		.812*	.866*	.553	.821*	.857*

^an = 5

^bn = 6

*P > .05

**P > .01

Table 4. Spearman rank correlation between actual aggregate peer rankings and predictions based upon the information processing rules.

3. Who is best at handling people?

Information Processing Rules	i M1	ii SD	iii M1 + SD
Group			
1	.883*	.750*	.883*
2	.678	.946**	.893**
3	.669	.937**	.776*
4	.848*	.919**	.893**
6 ^a	.825	.825	1.000**
7	.401	.732*	.633
8	.803*	.964**	.893**
9 ^b	.471	.857*	.628
10	.598	.803*	.598

^a n = 5

^b n = 6

* p > .05

** p > .01

Table 5. Spearman rank correlation between actual aggregate peer rankings and predictions based upon the information processing rules.

4. Who has the most ability to think critically and analytically?

Group	Information Processing Rules		
	i QVC	ii C/S	iii QVC + C/S
1	.964**	.482	.821*
2	.928**	.035	.535
3	.964**	.857*	.964**
4	.883*	.830*	.964**
6 ^a	.900*	0	.725
7	.750*	.866*	.785*
8	.830*	-	.830*
9 ^b	.514	.214	.414
10	.705	-	.705

^a n = 5

^b n = 6

* p > .05

** p > .01

Table 6. Spearman rank correlation between actual aggregate peer rankings and predictions based upon the information processing rules.

5. With whom can you work best?

Group	Information Processing Rule i M1
1	.982**
2	.821*
3	.857*
4	.839*
6 ^a	.925*
7	.723*
8	.607
9 ^b	.814
10	.741*

^a n = 5

^b n = 6

*p > .05

**p > .01

Table 7. Spearman rank correlation between actual aggregate peer rankings and predictions based upon the information processing rules.

7. Who shows the best overall leadership qualities?

Group	Information Processing Rules		
	i SD	ii M1	iii SD & M1
1	.857*	.928**	.928**
2	.946**	.571	.857*
3	.928**	.678	.750*
4	.973**	.919**	.928**
6 ^a	.200	.900*	.675
7	.776*	.580	.794*
8	.946**	.875*	.928**
9 ^b	.800	.557	.742
10	.910**	.776*	.776*

^a n = s

^b n = 6

* p > .05

** p > .01

Overall, the predictive power of the models, developed from the protocol analysis, is high. It appears, however, that equally good or better predictions are obtained using simpler models than those derived from the protocols analysis. This is true for all socio-metrics except "With whom can you work best?" For example, the model based on the Listening rule by itself appears to be better for the sociometric "Who would you go to for help on a tough problem?" Using the criteria that the higher the Spearman r_s values the better the rank correlations, six of the nine groups had higher r_s values using this simpler model over the previous one which was composed of the Listening and Mutual Influence factors. As was mentioned, for "Who was pulling most for the group?" the simpler model combining the factors of Social-Directive and Quantity of Verbal Communication had eight higher r_s values than the model derived from the protocols which included these two factors in addition to the Listening parameter. For the socio-metrics "Who is best at handling people?" and "Who shows the best overall leadership qualities?", the model based on the Social-Directive factor by itself appears to be statistically better than the model based on the Social-Directive and Mutual Influence factors together, with seven and six of the nine groups having higher r_s values respectively. Finally, the model using the Quantity of Verbal Communication rule only, appears to have better predictive validity on "Who has the ability to think most critically and analytically?" with four higher r_s values than the protocol analysis model which consisted of the Quantity of Verbal Communication and Categorizing/Summarizing parameters.

The Spearman rank correlation is a good indicator of a model's predictive power for a particular group, however, it is not sensitive enough for making a selection between the models for a sociometric over all groups in general. This is due to that fact that the r_s is calculated for each individual group and thus the models are not evaluated over all of the groups in the aggregate. One method to determine which models are best over all groups is to perform a comparative frequency analysis of the deviations of the various models from the actual aggregate peer rankings. In otherwords, using the same data, the frequency for which there was a perfect match between a model and the actual aggregate peer ranks, where the model prediction was off by one adjacent rank, off by two ranks, etc., is calculated. Table 8 illustrates this procedure.

Table 8. Example of a perfect correlation of the model for a sociometric with the actual peer rankings.

		Model Predictions						
		1	2	3	4	5	6	7
Actual Peer Rankings	1	1.00						
	2		1.00					
	3			1.00				
	4				1.00			
	5					1.00		
	6						1.00	
	7							1.00

In this example, where there are ones along the diagonal, the model predictions are perfectly correlated with the actual peer rankings, there are no deviations. This, of course, is the ideal model. In each case, the closer a model is to looking like this table the better it is. Hence, in selecting which model is best over all groups on a particular sociometric one would choose that model which minimizes the overall deviations.

As yet, this method of analyses has not been completed. Further results will be reported in a future technical report.

DISCUSSION

The results to-date can be viewed as strongly supportive of the experimental approach taken in this research. The naive additive models seem to capture the essential information which is being processed by the subjects; and they are basically supportive of the human problem solving theory proposed by Newell and Simon (1972). The effectiveness and simplicity of these unweighted cognitive processing models -- with regards to the few and operationally defined decision rules which represent the information being processed by the subjects -- are encouraging with regards to their potential implications for decision process modelling research on managerial selection and assessment, management development, and organizational design.

Surprisingly, it appears that even simpler models exist which predict the peer rating criteria than those derived from the protocol analysis; particularly in those instances where nonverbal communication

is a primary factor. For all of the sociometrics, except for the question concerning critical and analytical thinking, the processing of nonverbal cues was a crucial component in forming a judgement. For example, the primary parameter, as indicated by the protocols, for the sociometric "With whom can you work best?" is Mutual Influence. This factor combines information obtained from (1) verbal communications (i.e. those interactions which connote give and take: agreements, disagreements, and building); and (2) nonverbal communications (i.e. dogmatic-aggressive characteristics: rigid body posture, poor eye-contact, no head nodding, etc.). Table 9 shows the r_s scores for the Mutual Influence factor, first computed using the verbal give and take communications only, second is the same score with the nonverbal dogmatic-aggressive behaviors added. It is clear from the increase in the significance of the r_s values, when the nonverbal communications are considered in the Mutual Influence score, that it is an important variable. Using a two-tailed t Test the two series of r_s values are significantly different at the .01 level.

Table 9. Spearman rank correlations for the predictions of a model with and without nonverbal communications considered.

5. With whom can you work best? Model: Mutual Influence

Group	Verbal (give & take)	Verbal & Nonverbal (dogmatic & aggressive)
1	.929**	.982**
2	.429	.821*
3	.857*	.857*
4	.839*	.839*
6a	.075	.925*
7	.384	.723*
8	.607	.607
9b	.243	.814
10	.489	.741*

a n = 5

b n = 6

* p > .05

** p > .01

A possible explanation for the dominance of nonverbal information in these IP models may be obtained from a further examination of the group situation itself. In such a group discussion with six other individuals to listen to, interact with, and judge, it is possible that there may be an information overload. For example, in order for a person to rank the six other members of his group on the socio-metric "With whom can you work best?" he would first have to make a judgement on the give and take exchanges: i.e. how many times each member agreed, disagreed and built on his ideas. Next, he would have to recall the various nonverbal cues elicited by each member indicating dogmatism, aggression and listening; add this to his count of give and take exchanges; and finally arrive upon a ranking for all six members.

Therefore, it seems likely that, in such an information rich environment, a subject makes an attribution on how a person would rank on these sociometrics using nonverbal information as a surrogate for processing a detailed account of all the verbal transactions. It is possible that persons form opinions of their peers early in the communication and rely thereafter more heavily on the nonverbal rather than the verbal information. Prior research has shown (Lewin, Dubno, Akula (1971); Hollander, 1956 a, 1957, 1965) that valid and reliable peer evaluations are obtainable in relatively brief interaction times. This is an interesting research question which may be easily answered from our videotaped record of the group interactions.

Another interesting finding is the commonality of the underlying models for the sociometrics. There appears to be no separate descriptors from each subject for each group, instead a consistent common

set of descriptors emerge for each sociometric, except for the question "Who shows the greatest independence of thought?", where no common set of descriptors, which could be scored, were identified. This finding lends support for the method of developing situational process descriptors for how people attribute behavioral characteristics to others.

Our research findings have a direct bearing on the literature describing the emergent leader of a group as that member who talks most frequently, independent of the content of his verbalizations (Bass, 1949; Norfleet, 1948; Bales, 1953; Borgatta and Bales, 1956; Kirsh, Lodahl and Haire, 1959; Riecken, 1958; Regula and Julian, 1973). Due to the fact that no study had shown that the quality of a person's contributions modifies the leadership ratings he receives (cf. (Riecken, 1958; Bavelas, Hastorf, Gross, and Kite, 1965; Regula and Julian, 1973)) and that other research findings (e.g. Stogdell, 1948; Julian, Hollander, and Regula, 1969) indicate that perceived and actual competence (presumably related to the quality of communication) are important determinants of leadership, Sorrentino and Boutillier (1975) set up a study to investigate the relationship between quantity and quality of verbal interaction on the leadership process. The two variables were systematically varied in an unambiguous group situation (e.g. High Quantity - Low Quantity, etc.). Their results indicate that while quality of verbal interaction was found to predict perceived differences on such variables as competence, influence, and contribution to the group's goal, only quantity of verbal communication predicted perceived differences in leadership ability.

Our data lends itself for the direct testing of Sorrentino and Boutillier (1975) results. Having the complete record of the verbal

transactions -- the number of words spoken, time length of verbalizations, the content and order of communications -- enabled us to test the relationship between the quantity of verbal communications and the rankings on all sociometrics. Specifically, we measured the quantity of verbal interaction by the number of utterances and by the number of opinions stated. Neither of these measures were significant in predicting the peer ranking criterion for all sociometrics except one -- "Who has the most ability to think critically and analytically?" In addition, the quantity of verbal communication was indicated as one of the two primary parameters for the model of the sociometric "Who is pulling most for the group?". Of particular interest is the relationship between the quantity of verbal communication and the peer rankings for the question "Who shows the best overall leadership qualities?" No correlation was found between the ranking based on the quantity of verbal communication and the actual peer rankings for this question. This is not surprising, however, since quantity was not heavily expressed in the protocols as being an important leadership quality.

In general, we may conclude that the findings from our study contradict the earlier findings that the quantity spoken is more critical than the quality of interactions when it comes to attributing leadership. The fact that we found that the number of opinions expressed had overall higher r_s values than those obtained from a straight word count, in itself, indicates that subjects were making some judgement on the content of the communications.

Riecken (1958) reports evidence that unless a group member has a high participation rate in the early stages of the group discussion,

other members will not attend to him even if he comes up with an "elegant solution" to the group's task. In two of our groups this notion was not supported. In both cases a member with a considerably low overall rate of participation was ranked high on leadership abilities because of his opinions or suggestions late in the discussion concerning the group's task.

The findings of this study may also have implications to another large body of research on leader behavior. Specifically, the Mutual Influence factor has not been given explicit recognition in the Consideration and Initiating Structure literature. Hollander (1976) has also noted the importance of a similar factor in the leadership process when he refers to a "transactional" social exchange. This "has to do with the leader-follower relationship in the aggregate, including the followers perceptions and expectations, the availability of two-way influence, and exchange of rewards" (1976 p.1). Our findings not only indicate that a mutual influencing exchange is a vital component in one-to-one relationships, but that it is also important for a leader to have this type of exchange with the majority of the group members. This is consistent with Leavitt's (1951) findings on effective communication networks. His results indicated that the Wheel network produces the best organized and fastest performance. This is the most centralized of Leavitt's (1951) four networks, where one person -- who usually becomes the leader -- is the focus of comments from each member of the group.

Further, our results suggest other activities which are not specified in the Initiating Structure dimension of leadership. We found two leadership qualities which help structure the decision-

making group: the ability to provide direction and the power to facilitate problem solving. The descriptors which identified the quality of giving direction include "initiating and organizing the discussion," "soliciting ideas from other participants" and "keeping the discussion on track." The descriptors of "categorizing and summarizing" and "having a comprehensive view of the problem", etc., proved to be indicative of the ability to facilitate problem solving by giving perspective and guidelines to the discussion. In addition, as was indicated in the protocol analyses, to be most effective a leader must be able to perform these directive behaviors in a socially acceptable manner. This means listening and being considerate of others' opinions as well as giving structure to the group.

Although complementary to the literature, the results of this research poignantly reveal the need for further investigation into leadership attribution theory.

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